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(71) Applicant *(for all designated States except US)*: DUSKEDGE PTY. LTD. [AU/AU]; 100 Northbourne Avenue, Canberra, ACT 2601 (AU).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: MANCLARK, Barry [AU/AU]; 22 Blackham Street, Holt, ACT 2615 (AU).

(74) Agent: PIZZEYS PATENT & TRADEMARK ATTORNEYS; P.O. Box 291, Woden, ACT 2606 (AU).

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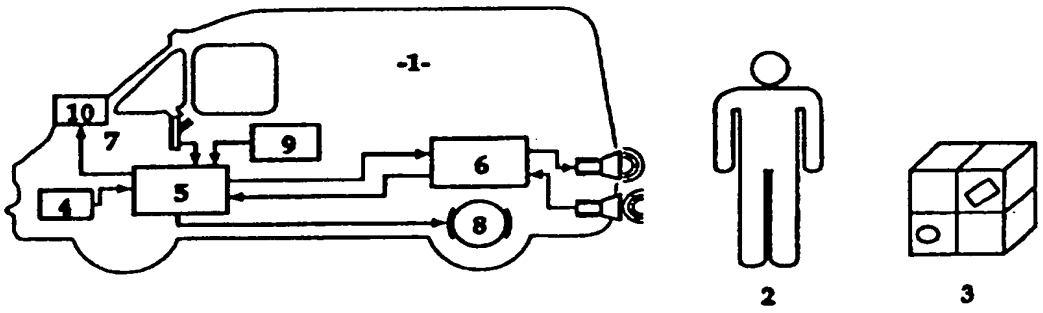
(54) Title: A COLLISION AVOIDANCE SYSTEM



(57) Abstract

A collision avoidance system for a vehicle, the system including: transmitting means for transmitting a signal; receiving means for receiving the transmitted signal when reflected by an object; and processing means for calculating the distance between the vehicle and object, wherein the processing means is adapted to operate actuating means when the calculated distance is less than a predetermined distance.

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"A COLLISION AVOIDANCE SYSTEM"

TECHNICAL FIELD

This invention relates to a collision avoidance system for a vehicle.

This invention has particular but not exclusive application to heavy vehicles such as trucks which have visibility problems when reversing.

BACKGROUND ART

It is well recognised that rearward visibility from a truck is poor. Furthermore, even when an object is sighted, it is difficult for the truck driver to judge the distance to an object during reversing of the truck.

A number of systems have been proposed to address these problems.

For example, US Patent 5,303,205 discloses a system in which ultrasonic transducers are mounted on a truck. The ultrasonic transducers provide the driver of the truck with a distance readout. The readout is advantageously mounted in the truck's reversing mirror.

Other systems incorporating optical and microwave transducers are also known.

The present invention relates to an improved collision avoidance system.

DISCLOSURE OF INVENTION

This invention in one aspect resides broadly in a collision avoidance system for a vehicle, the system including:-

transmitting means for transmitting a signal;

receiving means for receiving the transmitted signal when reflected by an object; and

processing means for calculating the distance between the vehicle and object,

wherein the processing means is adapted to operate actuating means when the calculated distance is less than a predetermined distance.

Preferably, the actuating means is associated with the brakes of the vehicle. Alternatively, the actuating means is associated with a motor for retarding the approach of the vehicle towards the object.

Preferably, the processing means also calculates the closing velocity of the vehicle and the object and the predetermined distance is dependant on the calculated closing velocity.

BRIEF DESCRIPTION OF DRAWINGS

In order that this invention may be more easily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate a preferred embodiment of the invention, wherein:-

FIG 1 is a schematic diagram of a collision avoidance system according to the invention;

FIG 2 is a block diagram according to the invention;

FIG 3 is a schematic illustration of the indicating means;

FIG 4 is schematic view of the brake control circuit; and

FIG 5 is schematic example of the implementation of the system.

BEST MODE

With reference to FIG 1 there is illustrated vehicle 1, animate object (person) 2 and inanimate object 3.

The system may be adapted to discriminate between animate and inanimate objects. For example, the system may include infra-red sensing means. Alternatively, the system may include motion sensing means or means for calculating the velocity of the detected object to determine whether or not it is animate or inanimate, or

more strictly mobile or immobile.

Telesonic sensor 6 is an ultrasonic transceiver, although in other embodiments it may be another form of transducer such as, for example, a low powered microwave transducer.

In the illustrated embodiment, an ultrasonic signal having a frequency of 40 kHz at <20 vDC is generated. This signal is fed to output transducers whereby a longitudinal wave is transmitted at approximately 331 metres per second depending on atmospheric conditions. The system may include means for compensating for temperature and/or pressure variation. It would be understood that the system calculates distance based on the time delay between transmission and reception. Accordingly, variations in atmospheric conditions will be influential and a look up table may be included to enable compensation. A look up table is not required if the transducer utilises an electromagnetic signal rather than a longitudinal sound wave.

Telesonic controller 5 communicates with Telesonic sensor 6 and includes processing means for calculating the distance between the vehicle and detected object based on the time delay between transmission and reception.

The calculated distance is displayed to the driver by display means 10. Display means 10 may include audio and/or visual indicators. The display means may include a read out of the distance and/or may include an audio output with an increase in frequency as the distance to object closes and/or may include a visual output having an intensity which is inversely proportional to the distance.

Telesonic controller 5 also receives input from gearbox 4. In this regard the system is only activated when a reverse gear is selected rather than having the system active at all times. There is also a manual override or inhibit switch 7 which can be operated by the driver of the vehicle.

Telesonic controller 5 also receives input from parameter switches 9. Parameters relating to the system may be selectively varied by the operator of the vehicle or may be set when the system is installed at parameter values appropriate to the particular vehicle.

Telesonic controller 5 is capable of actuating braking system 8. In this regard the brakes will be automatically applied if the vehicle approaches within a predetermined distance of the object. The predetermined distance is dependant on the approach velocity of the vehicle to the object. Thus, if the vehicle is approaching the object at a high speed then the predetermined distance is set at a larger value so that the speed of the vehicle can be retarded before the object is struck.

The application of the brakes is subject to further criteria being satisfied. For example, the truck must have reverse gear engaged and the manual inhibit switch must not be activated.

With reference to FIG 4 there is illustrated a simplistic view of the brake control circuit showing redundancy features. Similarly, with reference to FIG 5 there is schematically illustrated an example of the implementation. Another example would be to implement the counter using a timer interrupt rather than including it in the main procedure.

Whilst the illustrated embodiment relates to a land based application this system can also be used in marine environments, for example in controlling the docking manoeuvres of a ship relative to a wharf. In such an application the system can be used to actuate a bow thruster or stern thruster, for example, to prevent collision with the wharf.

Whilst FIG 1 shows only a single transceiver, the system can include multiple transceivers which are preferably spaced in an array across the back of the vehicle. The array may be one dimensional and may extend across the back of the truck. Alternatively, the array

may be two dimensional and may extend across the back of the truck and also vertically up the back of the truck.

Such a system has a number of advantages. Firstly, it gives comprehensive coverage rearwardly of the truck. Secondly, the array can be used to identify the location of any object located (see FIG 3).

The array of transceivers can have a corresponding array of indicators visible to the operator of the truck. If an object is located at the left of the truck then the left hand indicator will indicate this location to the operator of the truck. If the object then moves to the centre of the rear of truck then the central indicator will be activated and so on. Thus, an object can be tracked as it moves across the back of the truck. In reality, the driver would observe his mirrors and would probably see the object pass behind the truck and could then track it across the truck with the array of indicators until the object emerged on the other side and became visible in the reversing mirror.

With reference to FIG 3 there is illustrated a display which is visible to the operator. As previously discussed, the display may be located in the reversing mirrors or may be mounted on the dashboard. The system includes a system malfunction light, auto-brake application indicator and indicating means for indicating to the operator the location and distance of a detected object. The indicating means includes a numeric display which displays the distance to the nearest detected object. The indicating means also includes a one dimensional array of indicator lights, the intensity of which increase as an object approaches. The location of the object is indicated by the individual light in the array which is brightest. Alternatively, the individual lights may be replaced by bars of LEDS which are progressively lit as the vehicle approaches the object. Each LED may represent an increment in distance.

The system is adapted for mounting in all forms of vehicles.

The system is functional and accurate within the temperature range of -30 to 100°C and with relative humidity between 0 to 100%.

The system detects obstacles of a solid nature only i.e. excludes rain etc.

The system measures to an accuracy of at least 0.2 metres.

The system provides output which is not more than 5 milliseconds later that the time that the measurement was true.

The system provides a discrete electrical signal that indicates that the system is functional.

The system includes a system malfunction warning light which indicates when there is a problem in the system.

The system includes a manual inhibit switch which will disable the auto brake capacity while leaving the indicators active.

It is desirable that the auto brake only be operative in an emergency situation. An emergency situation is one in which the vehicle is reversing and is in imminent danger of collision causing injury or severe damage. While it is conceivable that the system be provided with a mechanism for evaluating whether or not an object is human or not (such as infra-red sensors), it is intended to consider any object to be possibly human, and any moving object to probably be human.

Factors to be taken into consideration of determining if an emergency situation exists are the distance to the object, the velocity of approach, and any acceleration in the approach. The time to collide with an objection can be estimated from the distance, velocity and acceleration of approach. Situations where a person or object move into the reversing path of the vehicle shall be seen as a sudden acceleration of approach. The system should consider the situation to be an emergency if there is insufficient time to stop the vehicle (given driver response for braking time) within the estimated

time to collision.

It is envisaged that the system will include three transceivers in order to provide redundant coverage and to provide reasonable directional information. The transmission of the transceivers may be staggered in the time domain. Alternatively, transmission of the transceivers may be staggered in the frequency domain. The use of multiple frequencies will reduce the risk objects not being detected due to their absorbent characteristics at a particular frequency.

Because the sensor knows when a transmission is made and the power level at which it is transmitted, it can determine the maximum possible return signal strength based on the time for the signal to return. This can be used to reject any signal whose strength is above a maximum threshold or above a maximum time delay. This can be used to filter out extraneous noise and signals which have been sent from other vehicles using the same system.

It is also possible that the transmission of the respective transceivers be coded to uniquely identify each transceiver.

In a more complex application the system can do more than merely actuate. In this regard the system can specify a power level to be applied to the brakes or other control system. For example, such a system could be used in the marine application where the system actuates bow thrusters or the like at variable power levels.

This system can be used in monitoring the movement of gantries such as are used in air bridges connecting an airport terminal to an aircraft.

This system is also applicable with loading vehicles working in confined spaces. For example, many accidents occur during the operation of forklifts. It is common practice for forklift operators to reverse gently into objects to obtain a maximum turning circle and to allow them to "feel" their way around confined spaces.

This system could be used to provide automatic braking such that any collision occurs at less than a predetermined maximum velocity. Such a system would allow the driver to continue to feel their way around whilst at the same time minimising damage and injury.

It will of course be realised that whilst the above has been given by way of an illustrative example of this invention, all such and other modifications and variations hereto, as would be apparent to persons skilled in the art, are deemed to fall within the broad scope and ambit of this invention as is herein set forth.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A collision avoidance system for a vehicle, the system including:-

transmitting means for transmitting a signal;

receiving means for receiving the transmitted signal when reflected by an object; and

processing means for calculating the distance between the vehicle and object,

wherein the processing means is adapted to operate actuating means when the calculated distance is less than a predetermined distance.

2. A collision avoidance system as claimed in claim 1, wherein the actuating means is associated with the brakes of the vehicle.

3. A collision avoidance system as claimed in claim 1, wherein the actuating means is associated with a motor for retarding the approach of the vehicle towards the object.

4. A collision avoidance system as claimed in claim 2, wherein the processing means also calculates the closing velocity of the vehicle and the object.

5. A collision avoidance system as claimed in claim 4, wherein the predetermined distance is dependant on the calculated closing velocity.

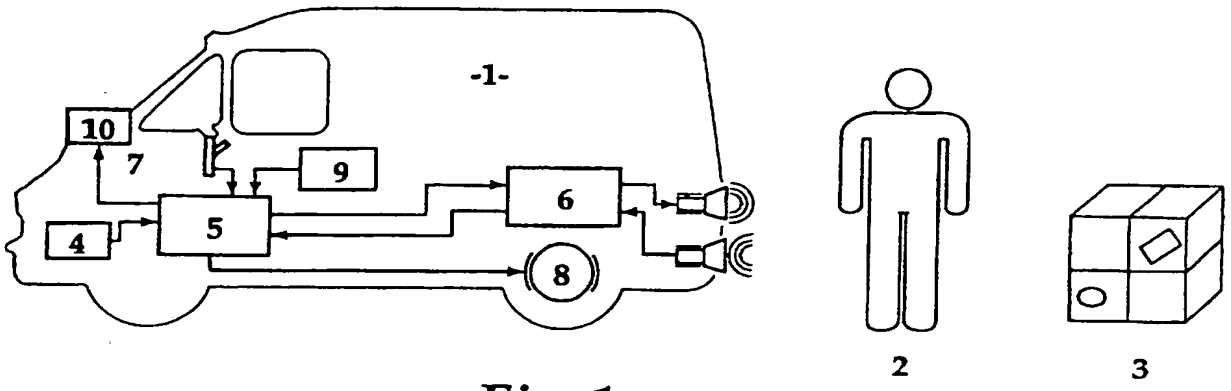

Fig. 1.

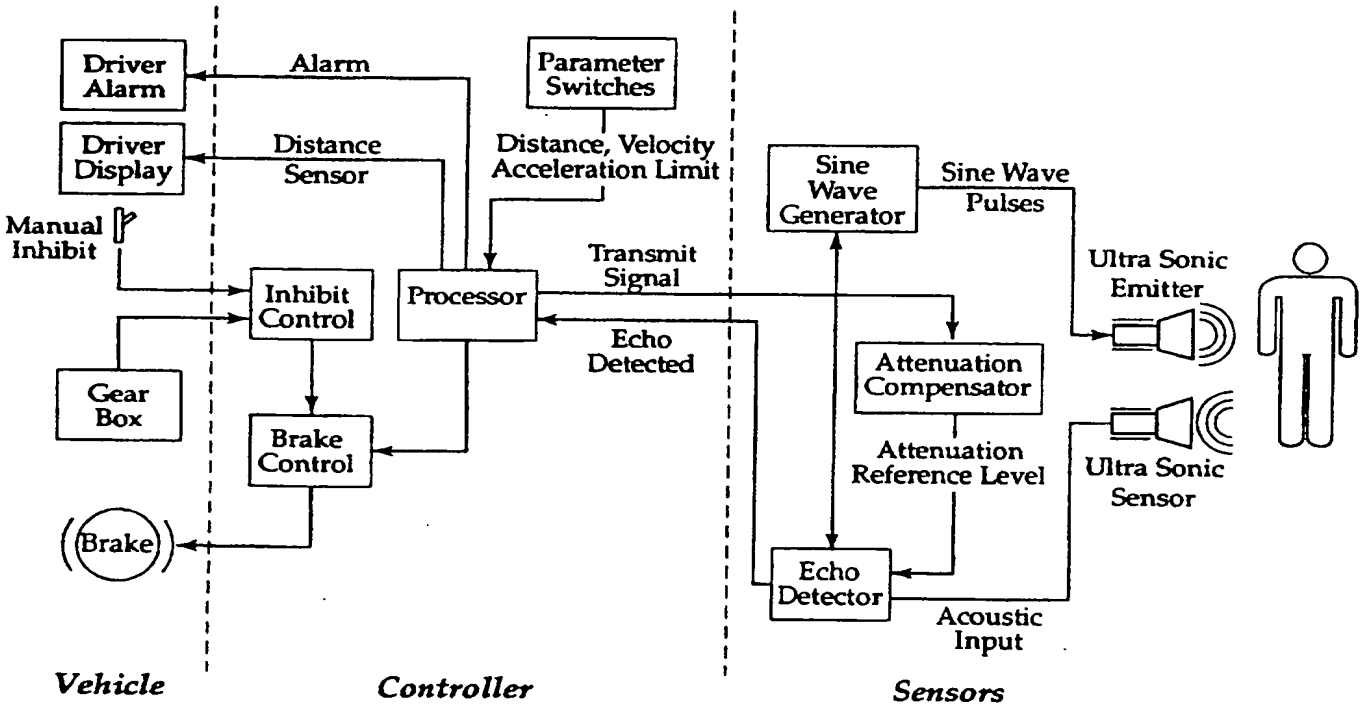

Fig. 2.

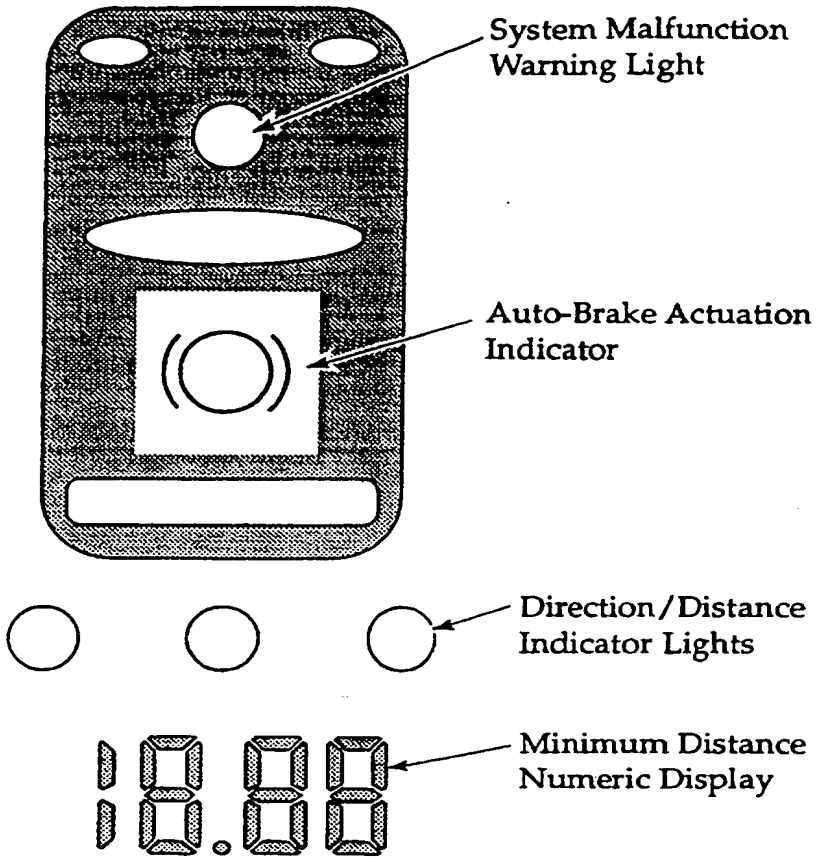

Fig. 3.

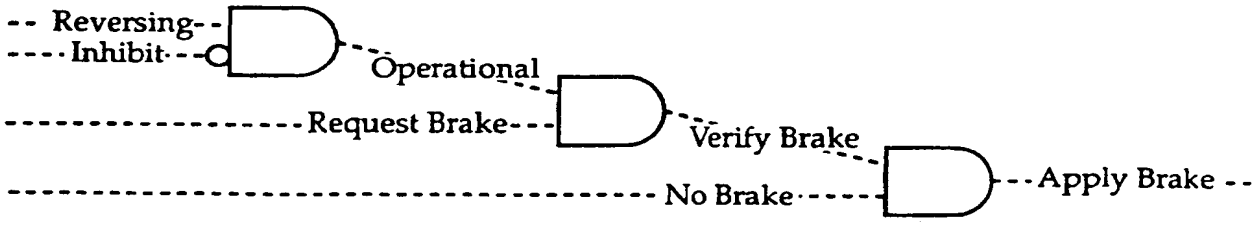

Fig. 4.

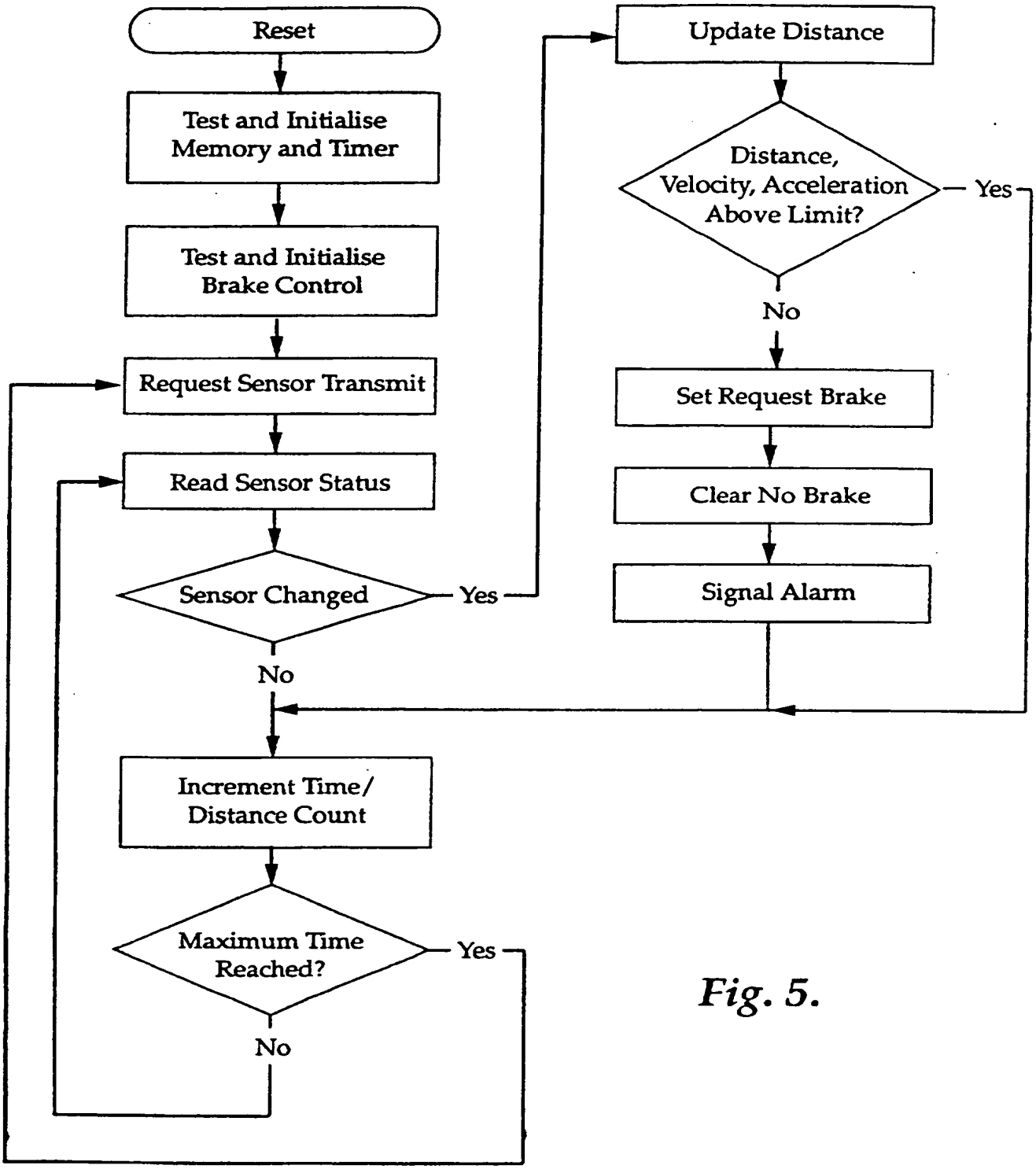

Fig. 5.

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 97/00412

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: G01S 15/06, 15/93, 13/06, 13/93; G08G 1/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: G01S 13, 15, 17; B66C 15/04; G08G 1/16

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 3121684 A1 (HAEFNER) 16 December 1982 Page 2 paragraphs 1 and 2	1-5
X	DE 4312595 A1 (LAUKIEN) 24 March 1994 Abstract	1-5
X	AU 63132/90 A (628655) 2 April 1992 (GUREVICH et al.) 2 April 1992 Whole document	1-5

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

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C (Continuation) **DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5303205 A (GAUTHIER et al.) 12 April 1994 Abstract, column 10 lines 1-48	1
X	AU 15480/92 A (SOLAR WIDE INDUSTRIAL LTD) 29 October 1992 Whole document	1
X	US 4464738 A (CZAJKOWSKI) 7 August 1984 Abstract, column 2 lines 22-27	1
X	GB 2139036 A (NISSAN MOTOR COMPANY LIMITED) 31 October 1984 Abstract	1
X	DE 3012236 A1 (CRAVEN) 2 October 1980 Whole document	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.
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This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	5303205	US	5373482	AU	46647/93	CN	1086016
		CN	1089036	IL	106210	IL	106211
		WO	9401787				
AU	15480	GB	9108120	WO	9218879		
US	4464738	AU	67787/81	DK	4669/81	EP	45763
		GB	2082325	NO	813530	WO	8102472
		ZA	8101179				
GB	2139036	DE	3415635	JP	59198378		

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